THE VALUE OF DIFFERENTIAL BLOOD COUNTS IN THE DIAGNOSIS OF MALARIA

BY

E. RANDOLPH ARMSTRONG, M.D., Ch.B. Liver., D.T.M. Liver., D.P.H. Cantab., Capt. I.M.S.

(*Received for publication* 30 *December*, 1915)

I. INTRODUCTION

After a considerable amount of work in the making of differential blood counts both in health and disease—and especially in malaria—I came to the following main conclusions:—

(1) That the increase of large mononuclear leucocytes found in malarial bloods is a fairly persistent change;

(2) that this change of ratio, evidenced by a differential count, is sufficiently specific to form a reliable test of infection; and

(3) that the phenomenon persists after the time when parasites disappear from the blood-stream (i.e. when parasites are no longer discoverable by practical microscopy), and so permits of a post-febrile diagnosis being made.

The above three assertions, in addition to subsidiary points, are elaborated below. The observations were conducted over a period extending from October, 1912, to July, 1914. The majority were carried out under conditions eminently suitable for the elimination of error—points which will be dealt with later.

II. NECESSARY DEFINITIONS

Owing to the confusion which still exists in the identification and classification of blood cells, it is well to define first the standards and method adopted by the writer.

(*a*) *Cell Constituents of the Blood*

The following blood cells, excluding those of rare diseases, are

well known:—Polymorphonuclear Leucocyte, Eosinophile Leucocyte, Large Mononuclear Leucocyte, Large Lymphocyte, Small Lymphocyte, Mast Cell, Transitional Cell, Endothelial Cell, Broken Nuclei.

No observer, as far as I know, gives the results of differential blood counts with such elaborate tabulation. Were this so, a common basis for comparisons would be found.

(b) My Grouping of the Cells

To disregard or incorporate under another heading any of the above cells is obviously a faulty proceeding. The error will be small, however, if the cell—omitted or misnamed—is a rare constituent of the blood.

At first, unfortunately, I omitted to enumerate broken nuclei, and so an error exists in the earlier counts. I hope to show, however, that this omission in no way prejudices the inferences to be drawn from these counts. Later, a separate class was assigned to them.

The transitional cell, as it appears to behave like the large mononuclear, has been incorporated with the latter.

The endothelial cell, very rarely seen, has also been enumerated with the large mononuclears.

My method of classification of these two rare cells is probably little different from that of other observers. Assuming this to be the case, we still find difficulties in comparing counts, owing to the divergent views on the classification of the large mononuclear leucocyte and the large lymphocyte. This divergence is so important, and affects, as I hope to show, the value of the count so materially, that a detailed description of these cells is given now.

Large Lymphocyte

The nucleus is circular or somewhat square. The shade of stain acquired with Leishman's is from deep blue to purple, but not pink or violet. The colour is not so deep as in the older or more compact nucleus of the small lymphocyte. The nucleus fills from one-third to one-half of the cell, and the protoplasm also takes on a bluish tinge. The latter is either clear or hazy, as if filled with semi-transparent jelly. It may or may not contain azurophile granules.

Though actual size is a matter of how the slide is prepared, yet relative size must be the factor in dividing the small from the large lymphocyte.

In the bulk of my counts the standard of differentiation between these two cells was made as follows:—Any lymphocyte of the size of, or larger than, the average polymorph in the film was assigned to the large lymphocyte class, and all lymphocytes smaller than the polymorphonuclear to the small lymphocyte class. In a few earlier counts the standard was different. (*Vide* Paragraph 5 (*a*).)

Large Mononuclear Leucocyte

The following essential characteristics were seen before any cell was placed in this class (as most of the distinctions are relative, a rapid survey of the slide is advisable, when relative sizes and depths of staining can be registered mentally):—

(1) The cell must be as big as the largest polymorphonuclear seen. The size of the large mononuclear is almost invariably, of course, much larger than this standard. The envelope is usually of irregular shape.

(2) The nucleus must show less depth of stain than the nucleus of any other white cell in the film (excluding the mast cell when the nucleus of this fails to stain). Usually, with a stain working well, it is of a cherry-violet colour, as opposed to the bluish purple of the large lymphocyte.

(3) The nucleus is woolly in appearance, sometimes ovoid (true large mononuclear), sometimes kidney-shaped (transitional cell), and very rarely squarish (endothelial cell). It is never circular.

Other normal characteristics are:—

(4) Presence of chromatin granules. These are usually triangular chips, but may appear as dots, and their total numbers rarely exceed ten. Absence of these in a typical cell with the above three characteristics does not, with me, debar the cell from this class, as the granules may be obscured from vision by a superimposed nucleus.

(5) The protoplasm is usually clear and non-staining, or faintly blue. Often the envelope is ruptured and the protoplasm lies scattered, but the envelope remains apparent as an almost complete cell.

Absence of any of the three essential characteristics led me to place the cell in the large lymphocyte class.

Characteristic in Malaria:

(6) Pigment is often observable, lying within the protoplasm. This might be confused with superimposed dirt, which, however, is avoided by careful staining methods.

(*c*) *Method of Staining*

Leishman's stain, formula, and method were used up to the point of application to the film. From this point I carry the staining to a state of overstain and consequent deposit. The stain is then poured off and, with the slide held under a tap, two drops of pure alcohol are made to run down the surface. Immediately these have reached the bottom, the slide is put in the water stream. The slides are only just washed and then are blotted dry, the drying being hastened by gentle warming if necessary, otherwise uneven coloration results. This finishing method avoids the use of distilled water for washing, and the light wash of alcohol on an overstained slide does not decolorize too much, but, on the contrary, gives a perfect pink colour to the red blood corpuscles and ensures a complete absence of dirt.

(*d*) *Method of Counting from the Smear*

All counts were made from any part of the smear, as I have never found any preponderance of a particular cell in any special area.

The number of leucocytes counted, where not stated in the Tables, was any round number from 100 to 800.

III. CERTAIN ERRORS. HOW AVOIDED

(*a*) *Error of Nomenclature*

To ensure uniformity each cell must be identified correctly and the same classification be adopted throughout. Such uniformity exists in my counts with the two slight exceptions already mentioned; i.e. the omission of broken nuclei and a different standard of differentiation between the large and small lymphocytes in the earliest counts.

(*b*) *Error of Bias*

In order to avoid any possible objection of trying to prove a preconceived theory, I made a point of having nearly every slide numbered only, the suspected disease—if any—man's name, etc., being kept secret by my assistant until the count was made. More

especially, in order to avoid bias, slides of healthy men or of men with different ailments were intermingled indiscriminately with the malarial bloods. This was not always possible, as, occasionally, only one slide would come up for examination.

(*c*) *Error of Technique*

In part this error was eliminated by the stain being prepared, the slide stained and the count made by one person only. My assistant made every blood smear. The error of technique, despite these precautions, may still be large, as a little experience soon showed me that counts from the same patient may vary according to the way the smear is made.

This phenomenon was almost entirely confined to malarial bloods in which my count was disturbed by the presence of numerous broken nuclei. When this first occurred the question arose as to whether these nuclei could be ignored.

With a little consideration it is evident that there is only one conceivable circumstance in which these nuclei can be disregarded. This circumstance will be if the nuclei originate from all classes of leucocytes, and then only if their numbers are in the same proportion as their parent cells. Let us suppose a simple case where a count gives:—

Polymorphonuclear	60 per cent.
Large mononuclear	10 ,,
Lymphocyte	10 ,,
Nuclei	20 ,,

If the broken nuclei are ignored, we shall have counted 80 cells in the proportion of 60 : 10 : 10, and 100 complete cells will probably be in the proportion of 75 : 12·5 : 12·5. If the nuclei originated, in this example, from all three kinds of cells observed, then the same proportion might be arrived at by neglecting to count them, but if they originate from one class of cell only (say the large mononuclear), the count in reality will be polymorphonuclear 60 per cent., large mononuclear 30 per cent., and lymphocytes 10 per cent.

That all classes of leucocytes do not give rise to broken nuclei was evident, as I had already observed that they figured rarely in healthy bloods and commonly in malarial bloods, in which the concomitant change is one of increase of large mononuclears. I therefore made a separate entry for broken nuclei in future.

The presence of broken nuclei in excess is to be looked upon as an error of technique. I satisfied myself upon this point by experimenting upon a malarial blood, making films by rough and gentle methods. Those films prepared carefully by moving the blood uphill in the rear of the spreader gave the least number of broken nuclei, and, incidentally, the greatest proportion of large mononuclears.

(*d*) *Error of Insufficient Count*

For great accuracy it is said that at least 2,000 leucocytes should be enumerated. Time never allowed of this. In my later counts I fixed 400 as a minimum. This error, which could not be eliminated, should not influence the comparative value of the tables, although the positive value of any one table, taken alone, will be affected.

(*e*) *Error of Insufficient Sampling*

For still further accuracy a larger sample than one drop should be taken at one time, and, moreover, frequent sampling should be made throughout the twenty-four hours. Such a labour is almost beyond the capacity of one individual

In one respect my slides were nearly all uniform, inasmuch as they were taken in the early morning before digestive leucocytosis sets in.

(*f*) *Mathematical Errors*

Of the four principal methods of striking averages, the least reliable is used in my tables, i.e. the Arithmetic method. If another (say the Geometric) method is used, it will still be found that the averages exhibit the same relation to each other as is found by using the former method.

Mathematically it is true that averages need correction. As the great part of this paper deals with the difference between the average number of large mononuclears found in health and the number found in malaria, it will be advantageous to dismiss here the only argument which an actuary could apparently bring to upset the value of my findings.

If 5 is the average number of large mononuclears found in a healthy blood, and 400 cells were counted, an actuary can show by Poisson's formula that the number might be as *high* as

·05 + ·03 = 8 per cent. Again if 15 is the average in a malarial blood, and 400 cells were counted, the number might be as *low* as ·15 − ·05 = 10 per cent. In this event comparisons between a healthy and a malarious slide would be worthless. But we deal here with a large series of counts, and it would be absurd to argue that each individual healthy count was too low, and each malarial count too high.

IV. FIRST MALARIAL OBSERVATIONS

(*a*) *Station non-malarious*

The military cantonment, situated fifteen miles from Darjeeling, in which I became stationed early in October, 1912, offered ideal conditions under which to carry out the following observations, inasmuch as it was entirely free from Anopheline mosquitos and therefore non-malarious.

The barracks ranged from 4,500 to 5,500 feet above sea-level, and were built upon the side of a very steep mountain. Thus, though the rainfall was on the average 175 inches during the year, all rainwater quickly drained away.

The nearest districts where Anophelines prevailed and malaria was indigenous were at lower levels, and were rarely, if ever, frequented by the men of the battalion.

Personal search for adults and larvae of Anophelines invariably failed to give positive results; mosquito nets were never used, and the local reputation of the cantonment was that it was quite free from mosquitos.

The best proof that men of the regiment never contracted malaria whilst present with the battalion in this station is that the admissions for this complaint for the whole of 1912 and up to November, 1913, were made up of—

(1) Cases attacked whilst on duty in the Tista Valley.

(2) Cases beginning with a primary attack or relapsing immediately on return from furlough or on being newly recruited.

(3) Relapses of attacks already under observation, originating as either (1) or (2).

Thus if malaria were at all indigenous or had been contracted by the men during their off-duty times, there would necessarily have been cases which would not fall into any of the above groups. There were none.

(*b*) *Epidemic.* 59 *Cases of 'Fever'*

On my arrival in this station, the battalion—a Gurkha one recruited mainly from south-eastern Nepal—was split up into numerous detachments; the majority of the men were in cantonments, whilst the remainder were posted in companies and half-companies at intervals along the Tista Valley as far as the Thibet frontier.

Upon the return of the outposts, 59 cases of 'fever' were admitted into hospital, a figure representing nearly 25 per cent. of the men thus employed.

(*c*) *Quinine Test*

Other duties were so pressing that I had no time for thorough examination of each case on the day of admission. The first main procedure which I carried out, whilst at the same time commencing the task of taking cases in detail, was to divide the wards longitudinally and to treat empirically one side with quinine and the other side with diaphoretics only.

Results became apparent very shortly. On the quinine side, some cases responded at once to large doses (30 grains quinine per diem), others made no improvement whatsoever. On the other side, where diaphoretics were employed, the same state of affairs in time was noticed, but with this difference: the cases which showed decline of temperature to normal had no marked signs of malaria, e.g., enlargement of spleen, typical chart or the classical symptoms of this disease; whilst the cases uninfluenced by diaphoretics proved themselves to be malaria by typical intermittent periods.

(*d*) *Parasite Test*

Meanwhile blood examination was progressing, and results both positive and negative were obtained. It should here be noted that certain cases passed into convalescence without a diagnosis or a blood examination being made.

(e) Grouping by above Tests

Omitting clinical histories and tentative diagnoses obtained by examination at the bedside, the cases, by the above simple tests, arranged themselves as follows:—

A. Cases reacting to quinine and not to diaphoretics:—
   Charts typical ... *a*. Blood +, *b*. Blood −.
   Charts atypical ... *a*. Blood +, *b*. Blood −.

B. Cases not reacting to quinine but to diaphoretics:—
   Charts atypical ... Blood −.

C. Residuum of cases with notes incomplete, owing to convalescence.

Numerically the cases divided thus:—

19 cases with parasites present, and generally typical charts.

40 cases without parasites in blood, with a rough division possible from the appearance of the charts.

When treating cases empirically with quinine, I felt that no great stress could be laid upon 'apparent' reaction to the drug, as there must, by the laws of chance, be some cases whose fever would normally terminate on the day when quinine was started. Diagnosis could be accurately established in the case of 19 men. The remaining 40 cases presented an interesting problem. After a study of the notes on these cases and the clinical signs and symptoms, I was left with an open mind, though, in the bulk of the cases, the evidence was against malaria.

(f) Results of Differential Counts

Despite the convalescence of many of the cases, it occurred to me that a differential blood count might help me. I therefore began a systematic count of the blood of every one of these patients.

An increased percentage of large mononuclears is such a well-known change in malaria that the counts in the 19 cases of positive malaria, where parasites were found, called for no surprise.

For the sake of clearness I give these large mononuclear percentages in a separate table below, although the full counts can be traced in Tables 10(*a*) and 11 under the same case numbers.

(Note.—*Serial Numbers* in all these Tables are merely progressive totals of counts made. Where the same Serial Number occurs twice, the same count appears against it. They are used to facilitate reference.

Case Numbers are used in place of patients' initials, and occur over and over again. They are used to allow case counts to be traced through successive weeks.)

Table 1.—(19 cases, 19 counts.)

	Serial No.	Case No.	Large mono-nuclear percentage	Remarks
Day of attack	1	1	14·66	
,, ...	2	2	10·00	
,, ...	3	3	14·00	
,, ...	4	4	26·00	
,, ...	5	5	18·00	
,, ...	6	6	15·00	
,, ...	21	7	26·50	
,, ...	22	8	8·00	*Vide* Serial No. 269, Table 11
,, ...	23	9	22·00	
,, ...	24	10	19·00	
,, ...	25	29	24·00	
4 days after	270	12	21·00	
18 ,, ...	283	13	16·00	
19 ,, ...	285	14	15·00	
20 ,, ...	286	15	20·00	
21 ,, ...	287	16	19·00	
22 ,, ...	289	17	19·00	
22 ,, ...	290	18	18·00	
23 ,, ...	291	19	3·00	*Vide* Serial Nos. 297 and 312

The remaining 40 cases are now shown purposely divided into Tables 2 and 3. The full counts of Table 2 can be studied in the larger Table 13 under the Serial Nos. 238-253.

Table 2.—(10 cases, 16 counts.)

	Serial No.	Case No.	Large mononuclear percentage	Remarks
Day of attack	238	11	20·50	
,, ...	240	20	20·50	
4 days later	242	21	17·00	
4 ,, ...	243	22	13·00	
15 ,, ...	244	22	13·00	
17 ,, ...	245	23	15·00	
20 ,, ...	239	11	15·00	
23 ,, ...	246	24	8·00	*Vide* Serial No. 246, Table 13
32 ,, ...	247	25	23·00	
36 ,, ...	249	26	16·00	
40 ,, ...	251	27	14·00	
44 ,, ...	241	20	13·00	
48 ,, ...	253	28	16·00	
50 ,, ...	248	25	16·00	
63 ,, ...	252	27	15·00	
66 ,, ...	250	26	11·33	

Note.—*Case* No. 24 had a relative eosinophilia of 39·33 per cent. I also inferred a positive eosinophilia from the excess of leucocytes seen in the film. Assuming the positive eosinophilia to be 4,000 eosinophiles in 14,000 cells, in order to bring the polymorphonuclears to the healthy average found in a later table, the large mononuclears become 11·20 per cent.; or again, if the increase were 5,000 eosinophiles in 15,000 cells, which brings the average of the polymorphonuclears to that found in malaria, the large mononuclears become 12 per cent. This method of 'reduction to normal' is amplified in Paragraph 5a.

Whether I was right or wrong either in assuming the eosinophilia to be due to an additional infection or in including this case in this group, I prefer to leave it there now, rather than omit cases to improve the appearance of this table.

TABLE 3.—(30 cases, 36 counts.)

DIFFERENTIAL BLOOD COUNTS IN CONVALESCENCE FROM 'DENGUE FEVER'

Serial No.	Case No.		Poly-morpho-nuclear	Eosino-phile	Mast cell	Large mono-nuclear	Large lympho-cyte	Small lympho-cyte
168	1De	1st week	51·00	—	—	9·00	—	40·00
169	2De	,, ...	65·00	10·00	—	3·00	—	22·00
170	3De	2nd week	58·00	13·00	2·00	5·00	14·00	8·00
171	4De	4th week	72·00	9·00	1·00	3·00	14·00	1·00
172	5De	,, ...	52·00	8·00	1·00	5·00	27·00	7·00
173	6De	5th week	40·00	15·00	—	3·00	23·00	19·00
174	7De	,, ...	54·00	18·00	1·00	4·00	4·00	19·00
175	8De	,, ...	41·00	19·00	—	6·00	9·00	25·00
176	9De	,, ...	65·00	7·00	—	3·00	6·00	20·00
177	10De	,, ...	50·00	11·00	—	2·00	10·00	27·00
178	11De	,, ...	57·00	12·00	1·00	2·00	13·00	16·00
179	12De	6th week	47·00	3·00	—	4·00	17·00	29·00
180	13De	,, ...	38·00	20·00	2·00	4·00	9·00	27·00
181	14De	,, ...	49·00	6·00	1·00	2·00	14·00	28·00
182	15De	,, ...	54·00	8·00	—	4·00	9·00	25·00
183	16De	,, ...	41·00	16·00	—	3·00	11·00	29·00
184	17De	,, ...	70·00	14·00	1·00	1·00	8·00	6·00
185	18De	7th week	54·00	12·00	2·00	5·00	10·00	17·00
186	19De	,, ...	45·00	9·00	1·00	2·00	9·00	34·00
187	20De	8th week	42·00	17·00	1·00	2·00	13·00	25·00
188	21De	,, ...	64·00	4·00	—	4·00	10·00	18·00
189	22De	,, ...	50·00	19·00	—	3·00	13·00	15·00
190	23De	,, ...	47·00	12·00	—	3·00	17·00	21·00
191	24De	,, ...	70·00	7·00	2·00	2·00	7·00	12·00
192	25De	,, ...	52·00	10·00	—	4·00	22·00	12·00
193	26De	,, ...	56·00	14·00	—	4·00	10·00	16·00
194	27De	,, ...	57·00	4·00	1·00	3·00	6·00	29·00
195	28De	,, ...	47·00	16·00	—	1·00	7·00	29·00
196	29De	9th week	68·00	2·00	—	—	8·00	22·00
197	30De	,, ...	52·00	12·00	1·00	2·00	9·00	24·00

(*g*) *Grouping by the Differential Count*

I think it will be admitted that these 39 cases, by the parasite search and differential count method, group themselves naturally as I have distributed them in Tables 1, 2 and 3.

A study of these three tables shows the following main characteristics:—

Table 1. (*a*) The positive malarias show a high percentage of large mononuclears.

(*b*) This increase is maintained up to the fourth week.

Table 2. (*a*) There is a similar increase of large mononuclears.

(*b*) This increase is maintained up to the ninth week.

Table 3. (*a*) The large mononuclears are not half so high as in Tables 1 and 2.

(*b*) The percentage of large mononuclears decreases up to the ninth week.

(*h*) *Tentative Diagnoses*

At the time I felt justified in diagnosing the cases of Table 2 as malaria: Table 3 now caused further speculation.

I began to suspect that the 30 men of this table had suffered from dengue fever for the following reasons:—

1. Dengue fever was extraordinarily prevalent in Bengal and the district in which these men had been. I did not know of this fact at the time the men were in hospital.
2. Having learnt of this epidemic, I paid closer attention to the charts of these 30 men, now disentangled from the charts of men in Table 2, and found that these charts in the majority of instances showed the characteristic rise of temperature of dengue on the last day of fever. The precise day of fever cannot be worked out, as these investigations were made at too late a date for the actual patients, now out of hospital and well, to remember the exact date on which they fell sick in the Tista Valley before admission to hospital.
3. On coming to classify the cases and tabulate their names, regimental numbers, etc., I was immediately struck by the fact that all the men of Table 3 were men from one company, and this company had been no further along the

valley than the first post. Further, no case of malaria occurred in this company, 28 of the cases falling to two other posts, while the twenty-ninth case was contracted whilst the patient was on furlough.

(*i*) *Subsequent behaviour substantiating diagnoses*

All these cases, followed further, are of interest.

Men of Table 1 were placed on a quinine roster, and were advised to attend hospital weekly on Saturdays and Sundays for 10 grain dosage. Practically none availed themselves—hence a number of relapses occurred, and a Battalion Order became necessary.

Men on Table 2 were not placed on the roster, partly in order to see whether the diagnosis was correct, which, in view of the fact that Anophelines were not present in this station, I felt would be more assured if relapses were to occur.

Men of Table 3 were not placed on any after-treatment.

In the course of time the following results were noted:—

1. Two men of Table 2 relapsed with malaria, and as two more at the time of the count showed pigment in the large mononuclears, we may be sure that 4 of the 10 cases diagnosed by count suffered from malaria at their primary attack.

   All these cases did not relapse, probably for two reasons:—

   (*a*) Some had had a fairly severe dosage with quinine whilst in hospital. (Some, on the contrary, had none.)

   (*b*) As this was a hill station, we may suppose the effect of climate to be beneficial to recovery unaided by quinine, on the same principle that men with malaria, who cannot take the drug, are sent to the hills for the effect of such climate.

2. No man of Table 3 relapsed or came into hospital with any form of tropical fever during the ensuing eleven months. Beyond this, it is impossible to deduce anything further, as furlough or change of station supervened for these men, and so chances of malarial infection were re-obtained.

(j) Summary

Now, the corroborative evidence being strongly in favour of a correct diagnosis having been made with respect to 29 cases of malaria, and a correct 'exclusive' diagnosis of the remaining 30 (i.e. not malaria), I began to place considerable reliance upon the value of a differential blood count.

The following questions presented themselves for elucidation:—

1. What was the average count of healthy men of the battalion?
2. Was an increase of large mononuclears found in any other disease with which I had to deal?
3. Did such an increase occur at all constantly in malaria?
4. If an exclusive change in malaria, above what figure could one diagnose a case as malaria upon a count alone?
5. How long did the rise in large mononuclears remain during convalescence?
6. Could subsequent counts be made the scientific basis upon which after-treatment depends?

To arrive at the answers to these questions, I began by taking the blood of every man who came into hospital and of any others who could be persuaded to make the sacrifice in the interests of science.

V. SURVEY OF COUNTS IN HEALTH AND DISEASES OTHER THAN MALARIA

(a) Differential Count in Health

See Table 4. This table gives the counts made from 23 healthy men. These men were selected carefully, that is to say, at the time the blood was taken no disease was apparent or complained of, and later, if an examination of any man's medical history sheet disclosed an entry during the last two years of a disease likely to influence the count, e.g. malaria, syphilis, anaemia, etc., this count was discarded. There remained, of course, the element of chance that these men had suffered from some complaint during the furlough season, when no official check on their state of health can be kept.

A relative Eosinophilia will be noticed in certain cases. I had

no opportunity of investigating the question of worm infection. It is a fact, however, that worm infection is very prevalent amongst these Gurkha people, and also was much complained of amongst the neighbouring tea-garden coolies.

The principal fact to be noticed is that the arithmetic average of the large mononuclear leucocytes comes up to 4·68 per cent., a figure slightly higher than that found in text-books for European races.

Reference has been made in paragraphs 2 (*b*) and 3 (*a*) to an alteration in the standard of differentiation between the large and small lymphocytes. My first standard was to call any lymphocyte larger than the familiar shot-like small lymphocyte a large lymphocyte. An error, then, enters into this table, Table 3 and a few of the earlier malaria counts in which I adopted this first standard. As the malaria counts are much more numerous, I omit any correction for these earlier counts.

As some stress is laid later upon the normal percentage of large lymphocytes, a correction for this class of cell is now necessary in this table, for the percentage over the small lymphocyte group is too high, owing to the inclusion of lymphocytes smaller than the polymorphonuclear leucocyte.

The change in the standard of differentiation was decided upon in order that comparisons would be possible between my later counts and those of other observers who use the nomenclature advocated by Lieut.-Col. Sir L. Rogers, I.M.S.

This correction I take to be about 5 for the following reasons:—

1. Other observers, following Sir L. Rogers' nomenclature, which defines a large mononuclear as any mononuclear cell as large or larger than a polymorphonuclear (and therefore combines my large mononuclear and large lymphocyte), obtain an average for 'large mononuclears' of 10, whereas my average for true mononuclears comes to 4·68. The difference—5·32—should equal the percentage of large lymphocytes. This would give me a rather high correction figure of $12{\cdot}58 - 5{\cdot}32 = 7{\cdot}26$.
2. By a rather abstruse method of calculation, which may be open to error, I obtain what may be termed a healthy average from the next three tables, i.e., Tables 5, 6 and 7. These tables deal with lobar pneumonia, broncho-

pneumonia, and bronchitis, and in each table a relative increase of polymorphonuclears is noticeable. It is fairly safe to infer that, in all these diseases, an actual increase of this first class of cell occurs and that the leucocytosis only affects this cell; were this not so, one would expect a very much greater discrepancy between the relative percentages of the other cells which are found after employing the method of 'reduction to normal' shown below.

Let us first take a simple case. Assume 10,000 cells to be the average number found in 1 cubic millimetre of healthy blood. Assume the differential count to be:—

Polymorphonuclear	61·00
Eosinophile	6·00
Mast cell	—
Large mononuclear	3·00
Large lymphocyte	9·00
Small lymphocyte	21·00

Then in 1 c.mm. of blood there are

Polymorphonuclear	6,100
Eosinophile	600
Mast cell	—
Large mononuclear	300
Large lymphocyte	900
Small lymphocyte	2,100
	10,000

Assume in a case of pneumonia that the leucocytosis reaches 30,000 in 1 c.mm. of blood and that the excess 20,000 cells are all polymorphonuclear.

Then the number of cells in 1 c.mm. of diseased blood =

Polymorphonuclear... ...	26,100,	or a percentage of	87·00
Eosinophile	600,	,, ,,	2·00
Mast cells	—	,, ,,	—
Large mononuclear ...	300,	,, ,,	1·00
Large lymphocytes ...	900,	,, ,,	3·00
Small lymphocytes ...	2,100,	,, ,,	7·00

It is now easy to see that, if we are given the last count, we can find a figure reperesenting the actual increase, which, when deducted, will make the polymorphonuclears equal to the average found in health and at the same time restore the other cells to their normal average.

In applying this method to Tables 5, 6 and 7 it will be better to combine the averages of the polymorphonuclears and eosinophiles, owing to the fact that certain cases in the healthy table show marked eosinophilia at the expense of the polymorphonuclears.

The averages of these four tables, readjusted thus, are given below:—

	Polymorpho-nuclears and eosinophiles	Mast cells	Large mono-nuclears	Large lympho-cytes	Small lympho-cytes
Table 4—Health	67·64	0·42	4·68	12·58	14·67
,, 5—Pneumonia	88·13	0·11	1·93	3·01	6·82
,, 6—Broncho-pneumonia ...	75·37	0·11	2·15	5·56	16·81
,, 7—Bronchitis	73·44	0·13	2·68	5·93	17·82

If we assume the super-added increase in 1 c.mm. of blood to be 17,250, 3,140 and 2,180 in these diseases respectively, and employ the above method of reduction, we obtain new averages as below:—

	Polymorpho-nuclears and eosinophiles	Mast cells	Large mono-nuclears	Large lympho-cytes	Small lympho-cytes
Table 5—28 cases...	67·65	0·29	5·25	8·20	18·58
,, 6—9 cases	67·63	0·14	2·82	7·50	22·08
,, 7—16 cases...	67·64	0·15	3·26	7·22	21·70

The arithmetic average of these new counts, taking into account the number in each series, comes to:—

	Polymorpho-nuclears and eosinophiles	Mast cells	Large mono-nuclears	Large lympho-cytes	Small lympho-cytes
	67·64	0·23	4·24	7·787	20·12
as against	67·64	0·42	4·68	12·58	14·67

or a total of lymphocytes in health of 27·25 as contrasted with the new figure of 27·91.

The figure of correction, then, should be 12·58 − 7·79 = 4·79. This would make the healthy averages as follows:—

Polymorpho-nuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes
56·63	11·01	0·42	4·68	7·79	19·46

(b) Differential Counts in Lobar Pneumonia

See Table 5. These slides were always interesting. A positive leucocytosis could at once be inferred from the superabundance of polymorphonuclear leucocytes seen in a given field. In the absence of a haemocytometer, the leucocytosis can be roughly inferred by the method of 'reduction to normal' shown previously.

The enormous increase of polymorphonuclears, the highest of the series being 95 per cent., suggested to me a pneumonic infection; but here I would mention that I never had to deal amongst these Gurkhas with other septicaemias, appendicitis, acute suppurations, etc.—on the contrary, the bulk of admissions were for pneumonia, bronchitis, malaria and other fevers, and minor injuries. Thus, remembering the incidence of lung diseases, I, in nine cases, diagnosed pneumonia by the microscope without having seen the patient, and a visit to the ward later in each instance confirmed the accuracy of the diagnosis.

I lay no stress on this reverse method of diagnosis: the counts, however, are of great value in corroborating a clinical diagnosis.

It will be noticed that the eosinophiles decrease both relatively and positively—a fact in accordance with the results of other observers. This decrease seems to vary directly with the increase in the polymorphonuclears.

(c) Differential Counts in Broncho-Pneumonia

See Table 6. The affection of broncho-pneumonia, being less severe than the last disease, calls for less increase in the polymorphonuclears.

(d) Differential Counts in Bronchitis

See Table 7. A drop in the average number of polymorphonuclears still occurs, whilst the large mononuclears are more approximating to the figure found in health.

(e) Differential Counts in an Epidemic of unknown origin

See Table 8. The seven counts of this table are certainly striking, but, unfortunately, no diagnosis can be given to the causal condition. The smears were sent to me by a native tea-garden doctor, who described the disease as being epidemic and very fatal. The few symptoms given to me were that the disease resembled pneumonia, but the condition relapsed and different areas of lung were affected.

At the same time there was a similar epidemic prevailing amongst the native population of Darjeeling, and in some of these cases a plague-like bacillus was isolated from the sputum. The bacillus was not that of plague, however, and no further diagnosis was arrived at. This fact would tend to negative the assumption that the disease was enteric fever—a supposition which the counts would support.

The lymphocytosis is so marked that the disease is probably a distinct entity.

(f) Differential Counts in other diseases

See Table 9. This table shows the results found in all the different diseases which passed through my hospital. One or two cases were specially examined when the diagnosis was certain, to see if a known change could be recorded.

Thus, the lymphocytosis of syphilis is shown in Case No. 26D. It will be noticed that this protozoan infection does not increase the percentage of large mononuclears according to my nomenclature, but does increase the large lymphocytes which others classify as large mononuclears.

Infective polymorphonuclear leucocytosis is shown in Case Nos. 18D and 25D.

Case No. 14D was interesting. This patient was a Sikh woman who suffered from abdominal pain, low pyrexia in the evenings, alternate diarrhoea and constipation, anorexia and gradual but persistent loss of weight. On examination I could make out little except a feeling of hard lymphatic glands in the mesentery. The diagnosis looked like Tabes mesenterica, but I suggested doing a differential blood count before giving an opinion. This showed 15 per cent. of eosinophiles. Now this percentage, compared with those found amongst Gurkhas, was not startling, but I had reason

to believe that up-country people possessed counts more approximating to those given in text-books. Therefore I looked upon this count as a possible indication of worm infection, and elected to try santonin.

A large number of *Ascaris lumbricoides* was passed under this treatment, and again after a subsequent dose, and during the ensuing month a complete recovery from all symptoms was effected.

Case No. 12D had a moderately high large mononuclear count. This man had had malaria some months previously, and complained of debility at the time of examination. The blood showed diffuse* basophilia, and I think it is almost certain, from his clinical symptoms and from the improvement effected by quinine and arsenic, that this count was raised by reason of past malaria.

Case Nos. 27D-38D cannot be given a more precise diagnosis than 'chill with fever.' None had any symptoms of malaria, all yielded to diaphoretics and only remained in hospital for two or three days.

(*g*) *Summary*

All the foregoing counts, with the one exception mentioned, were made from the blood of Gurkha people. Table 10 (*a*) shows the counts of 39 malaria cases taken from the same race and on the day of attack.

The averages of these tables are now tabulated below:—

	Cases	Counts	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes	Broken nuclei
Health	23	24	56·63	11·01	0·42	4·68	12·58	14·67	—
Corrected average ...	—	—	56·63	11·01	0·42	4·68	7·79	19·46	—
Pneumonia	28	28	86·63	1·50	0·11	1·93	3·01	6·82	—
Broncho-pneumonia ...	9	9	71·48	3·89	0·11	2·15	5·56	16·81	—
Bronchitis	15	16	67·92	5·52	0·13	2·68	5·93	17·82	—
Epidemic, unknown origin	7	7	44·14	0·36	—	—	4·28	51·22	—
Other diseases, highest large mononuclear percentage	38	39	—	—	—	6·66	—	—	—
Malaria, benign tertian ...	28	28	60·05	4·73	0·32	14·56	3·52	16·64	0·18
,, malignant tertian	11	11	50·71	5·64	0·33	16·20	3·09	24·03	—

* *Diffuse Basophilia* or *Polychromasia*. Rarely did the preponderance of red corpuscles show this change. In scattered corpuscles it was common, and then almost invariably in malarial bloods.

It is evident that an appreciable increase of large mononuclears occurred in no disease with which I had to deal, other than malaria. Furthermore, this increase in malaria was almost constantly found.

At this period of the investigations I came to look upon a large mononuclear count of from 8 to 10 per cent. as suspicious of convalescence from malaria, and one of 10 per cent. or over as diagnostic of 'latent' or actual infection. The meaning which I assign to 'latent' malaria will be exemplified later. I consider it safer to place the figure upon which to diagnose malaria at a percentage at least double that found as an average in normal bloods, in view of the many errors which may enter into such counts.

VI. OBSERVATIONS UPON BLOOD DURING CONVALESCENCE FROM MALARIA

(a) Method employed

In order to find out how long, during convalescence, the large mononuclear count remained above 10 per cent., I carried out a rather disconnected series of counts on patients of Table 10 (a). Many more would, doubtless, have been made, had these men been in hospital instead of on duty.

Each count is entered in Table 11 as 'so many days after the first attack.' Provided no relapses occurred, averages could be struck immediately for the groups of counts in each week, but, as presumably each relapse will again influence the output of large mononuclears, it is necessary to re-group the counts (as in Table 12), and to treat each relapse as a fresh attack. Subsequent counts are then arranged at their proper interval from the last relapse. For the sake of clearness, all cells other than the large mononuclears are excluded from Table 12.

(b) Results of tabulation

By this method of bringing counts of relapses back to the 'first day of fever,' we note that the average large mononuclears increase from 15·02 per cent. (the average of all malarias, first day, amongst Gurkhas) to 16·88 per cent., this rise doubtless being due to the fact that severer infections are being dealt with.

As would be expected, the large mononuclear average declines from its height on the first day until it reaches a normal anywhere

from the twelfth week onwards. (One case, Case No. 19, is peculiar as the large mononuclear average remained low during the fever, and rose during convalescence.)

Up till the eighth week the average would appear to remain at or above 10 per cent. This point I lay great stress on, although the exact period of time may come to be altered with more observations.

This discovery has repeatedly been useful to me in practice. I have been consulted as to the probable diagnosis of fever contracted whilst shooting in the jungle, and recovered from by the time a doctor could be consulted. In such a case, if I find a high large mononuclear count, I unhesitatingly say that the disease was malaria, and advise a course of quinine treatment.

From the nineteenth week onwards, there is a larger group of counts, some of which were made whilst a new complaint existed. The fact that no malaria relapses occurred, when the resistance may be said to have been lowered by reason of a fresh illness, would go to prove that, with the large mononuclear count reduced to normal, 'latent' malaria was completely eradicated.

(c) Use of Count in treatment

Both Table 12 and the Table next to be discussed (Table 13) show that cases with high large mononuclear counts tend to relapse. Table 12 also shows that the normal average is not reached under quinine treatment until the twelfth week of convalescence; from this it would follow that after-treatment should be continued for at least three months.

Sir Ronald Ross lays down four months as a safe margin for the entire eradication of this disease; these figures support that contention.

My own practice in this battalion was to keep each malarial patient in hospital for one month, and to administer thirty grains of quinine per diem. After one month, if fit to be discharged, the case returned to duty and attended hospital twice weekly for ten grains of quinine until two more months had passed. In later cases I made use of the differential count to determine whether quinine should be discontinued. Only those men remained on the roster whose large mononuclear averages continued high.

VII. USE AND ACCURACY OF DIAGNOSING MALARIA BY COUNT ALONE

(a) In Non-malarious Station

The importance of this station being non-malarious must again be emphasised, as upon this fact depends the value of the ensuing investigations. The principle is simple, and consisted only in waiting for relapses in men whom I was led to suspect were malarially infected. The expectation was that these men, diagnosed solely upon their large mononuclear count, would relapse in at least as high a proportion as the known malarial cases relapsed.

See Table 13. In all, 22 men were watched. In 11 no further symptoms were noticed. The histories of the remaining 11 are now detailed.

4 men, mentioned in Table 2, are already known to be correctly diagnosed.

1 man, Case No. 34, returned from furlough, complained of debility, looked anaemic, showed a count of 19 per cent. large mononuclears, and was (perhaps rather unfairly) left without quinine treatment. Two hundred days later, during which interval the man had never left this non-malarious place, he returned with an attack of benign tertian malaria.

1 man, Case No. 35, relapsed in a shorter interval of thirty-two days.

1 man, Case No. 105, had his blood taken as a routine measure without any disease being complained of. The blood showed no parasites or any change indicative of malaria except a high large mononuclear percentage. The next day he was admitted to hospital with benign tertian malaria.

4 men remain to be discussed, and provide the best example.

Recruits, arriving from badly infected districts of Nepal, provided an excellent field for research. Not only did they frequently relapse with malaria, as experience had taught, but such relapses followed quickly upon their being made to undergo physical training.

I obtained the blood of 16 recruits at the time of the first

vaccination. Of these, 6 showed a large mononuclear count of over 10 per cent., and so were noted. These first counts are unfortunately missing. Of these 6, 4 came into hospital within the following three months with attacks of benign tertian malaria. (See Table 10 (a), Serial Nos. 10-12 and 20.)

Of the 10 recruits showing low counts, none were admitted at all.

Thus, out of 22 cases diagnosed upon count alone, 11 cases ultimately relapsed—surely rather a high percentage if the result were pure chance.

The cases of known malaria followed in Table 12 relapsed, despite quinine treatment, in the proportion of 1 to 3 (or 25 per cent.). The fact that 50 per cent. of the above cases relapsed, while doubly in favour of the correctness of my theory, is explainable probably by the fact that none of these suspected cases had undergone any treatment.

The reverse side of the picture must also be taken into account. There are 52 cases where malaria was excluded on count: these are 30 'dengue' cases, the 10 recruits mentioned, and 12 cases diagnosed only as 'chill with fever.' Out of these, none betrayed malaria by admission up to the time when the battalion left this non-malarious station—a period varying with each case from one year to one or two months.

(*b*) *In a malarious station*

In November, 1913, the battalion left for the plains and became split up into detachments.

From one detachment I kept receiving, monthly, very large admission rates, principally for malaria. Thus in a little over three months there were 218 admissions for 114 rank and file, of which 182 were for malaria. These 182 admissions were for 69 men.

As the season was unfavourable to such an epidemic, and the number of days spent in hospital by many cases was very small, I began to doubt the accuracy of the diagnoses. I decided to visit the district and, besides surveying the sanitary state of the camp, etc., to employ this method of blood-counting to estimate as far as possible the gross malarial infection.

It will be seen that I accepted the blood count method as accurate, and was about to use it as a standard. The probability was that this method had more to commend it than the rapid

diagnosis by thermometer and pulse-rate, which I found was practically all that was employed on the spot.

I was able to obtain the blood from 56 of these 69 men, and also from some who had had so far no admissions for sickness; 15 men were actually in hospital at the time of my visit, and 2 more who had had no previous illness were acting as sick attendants.

In the case of these 17 men, a clinical examination was possible. I refrained, however, from making this at once, in order that the examination might later be made use of as a check on the accuracy of my diagnoses arrived at from blood-counting.

First, I drew out a chart somewhat similar to Table 14 (q.v.), on which each of the 56 men was entered, along with the diagnosis returned, against the date of his last admission. The dates were arranged so that the last date came at the top. This date was March 5th, 1914, and on the same date all the blood smears were taken. We have already seen that in convalescence from malaria, the large mononuclear percentage remains at or above 10 per cent. for eight weeks. Therefore, eight weeks distant from March 5th a red line was drawn across the chart. Above this line, any case showing a large mononuclear count of 10 per cent. or higher could justifiably be diagnosed as having had malaria; below this line a doubt would remain if the count were lower.

With the 17 men capable of being examined in hospital, the method was to take blood-smears and to number the slides only with their regimental numbers—figures which one does not remember in association with a man's name. These counts were then made, but were not copied on to the chart.

The following day I examined each man under his own name, came to a diagnosis where possible, and then entered this diagnosis in the appropriate column of the chart. When these entries had been made (and not till then), the blood findings were entered from another book.

The results are, I think, strikingly interesting.

13 men were formerly diagnosed as malaria; of these, in

5 I clinically diagnosed malaria, found parasites and counts above 10 per cent.;

1 I clinically diagnosed malaria, found pigment and a count above 10 per cent.;

2 I clinically diagnosed malaria, and found counts above 10 per cent.;

3 I found no appreciable disease, and no evidence of malaria from charts, spleen, etc., and the large mononuclear count was low; and in

2 I found slight leucocytosis with polymorphonuclear increase, and clinically found lymphangitis and adenitis, although malaria was the return.

Four men were left, one with an old gumboil, one with dyspepsia, and two were the sick attendants. In all four of these I found low large mononuclear counts and a diagnosis compatible with that returned.

In these cases I could be sure of the accuracy of the findings.

With the remainder of the men, as I could make no examination, I could only scan their charts and enter remarks as to these on my chart. Here, the counts, in the light of the previous blood work, would warrant the assertion that diagnosis was wrong in 10 cases out of 24, and previous to January 8th was correct in 7 cases out of 15, after omitting the cases which showed parasites, and so were relapsing at the time of count. In these very old cases, the diagnosis was probably correct in 3 more, i.e., those giving large mononuclear percentages of 9·00, 9·50, and 9·33, respectively.

(*c*) *Further proof of theory*

In May, 1914, I left this Gurkha battalion and took up a brigade laboratory appointment in the Punjab.

The races of people now dealt with were mainly Jats, Sikhs, Dogras, and Punjabis. Forty-four more counts were made in malaria at the time of attack, and these are given in Table 10 (*b*). It is noteworthy, *en passant*, that the average of the large mononuclears in 42 benign tertian infections closely approximates to that found for 28 similar cases amongst Gurkhas, i.e., 14·46 per cent. : 14·56 per cent.

In the case of Serial Nos. 72-81 of Table 10 (*b*) and 261-267 of Table 13, examination was first made for parasites, the time allowed being, roughly, five to ten minutes in each case. No parasites were seen. Next, a lengthy blood count of 400 cells was made with each slide, and, the attention being perhaps too much directed to the white cells, no parasites were seen.

In each of these 17 counts a high percentage of large mononuclears was recorded.

In all previous counts of a similar nature, when parasites were not seen, the investigation stopped here, and the diagnosis was entered as 'diagnosed as malaria on blood count.'

But, as Sir R. Ross points out, the chance of finding a parasite depends directly upon the time expended. The total volume of blood in a man of average weight, he estimates, will contain 15,000,000,000,000 red blood corpuscles, and fever will not supervene in an infected man until there are 150,000,000 parasites.

Thus, in an early infection, 100,000 red blood corpuscles may have to be examined before a parasite is seen. Chance will, of course, make this number greater or less. If we assume an average of 200 corpuscles to one field, and that 20 fields are examined per minute with a one-twelfth oil immersion objective, it may be twenty-five minutes before a parasite is discovered.

Feeling convinced that the diagnosis by count was correct in these 17 cases, and remembering the factor of time in finding a parasite, I decided to continue the search. In 10 cases I was ultimately rewarded. Only one fever form was seen in each smear, and the shortest time spent in this continued search was thirty minutes; in the longest case, sixty-five minutes.

In two more cases pigment was seen, and finally the diagnosis of one case, Serial No. 266, Table 13, was confirmed later, the medical officer in charge notifying me that the patient had a sharp attack of benign tertian twenty-three days previously.

(*d*) *Summary*

The differential blood count has been the means whereby a diagnosis for or against malaria was arrived at in 103 cases.

42 cases were diagnosed as malaria by counts of 10 per cent. or over; 61 cases were diagnosed as not malaria by low counts.

Of the 42 cases, 27 were correctly diagnosed.

Of the 61 cases, 6 were definitely not malarial, 52 were followed for some months and did not relapse, and in 3 no further decision could be made.

(*e*) *'Latency' of malaria*

This work leads to the question: How does malaria remain 'latent'? Do we believe in encystment, in parthenogenesis, or simply

in diminished numbers? Personally, I incline to the last view, and if this is accepted, we can easily see how a total infection of (say) 150,000 parasites would require weeks of constant search, day and night, for the discovery of one parasite.

The presence of diminished numbers of parasites free in the blood-stream would reasonably continue to exert a toxic effect, and, if the toxic irritation is the factor in producing a large mononuclear increase, this increase will be maintained.

Whereas I looked upon a high large mononuclear count, at first, as indicative of a *past* infection, now I view it as a sign of either a very early *actual* infection with parasites or a diminishing infection. The blood is quick to react to purulent infection, and the leucocytosis again quickly recedes when the infective matter is removed. The mere abolition of fever, in malaria, does not, however, remove the infection.

Thus it appears to me that the method of diagnosis by blood count not only acts as an incentive to further search for parasites in early or late cases, but *also*, in the event of failure to find these, constitutes a fairly accurate method of diagnosis.

VIII. GENERAL OBSERVATIONS

(*a*) *Origin of broken nuclei*

It has already been remarked that broken nuclei were more abundant in malarial bloods. They therefore have some pathognomonic significance.

As to their origin, it is plain that neither the polymorphonuclear, the eosinophile, nor the mast cell can give rise to them, as these cells, when ruptured in a smear, betray themselves by their closely-scattered granules.

Again, the variation in the number of broken nuclei according to the method of slide-preparation, puts out of court any supposition that they may originate from other body-cells which are not present in drawn blood.

The small lymphocyte can also fairly be excluded, as this cell is relatively abundant in healthy bloods where broken nuclei are rarely seen. Since the time when I began to count the broken nuclei separately, there are many counts which show a very high percentage of small lymphocytes, and yet no broken nuclei are noted.

Between the large lymphocyte and the large mononuclear leucocyte the decision must therefore be made. My reasons for thinking the nuclei originate from the latter are three:

1. The impression left after many counts is that they were more numerous in malarial bloods, in which the other noticeable change is one of increase in the large mononuclears and decrease in the large lymphocytes.
2. The broken nuclei stain with a similar shade of colour to the nuclei of whole large mononuclears.
3. A mathematical reason. Studying the only (apparently) normal bloods in which full classification has been adopted, i.e., in Table 14, we find 23 cases in which 4,250 cells were counted, and 10 broken nuclei were noted. Against this there are 53 malarial counts in which 19,250 cells were observed and 128 broken nuclei were seen.

   Thus:

   4,250 healthy cells gave 10 = 0·002109
   19,250 malaria ,, ,, 128 = 0·006649
   The proportion is 2109 : 6649 = 1 : 3·15
   = 4·68 : 14·74

   or the same proportion as the healthy large mononuclear average is to the large mononuclear average in all malarial counts (i.e., 14·78).

The extraordinary nearness of these figures should not mislead, as the observations are few. I would prefer to lay more stress on the first two reasons.

It sometimes happens that a duplicate cannot be obtained of a slide in which broken nuclei figure to excess. In such cases it is worth considering whether the nuclei cannot be enumerated as large mononuclears. If the number is excessive, and still more if the irregular smearing, so peculiar to malarial bloods, and a slight degree of basophilia, punctate or diffuse, are present, then I should feel justified in suggesting the case was malaria.

(*b*) *Plasmodium tenue*

The last count in Table 10 (*b*) was made from a blood containing numerous parasites, exactly similar to the peculiar forms described by Professor J. W. W. Stephens, and so named by him. As some

consider that it is an actively amoeboid form of the malignant tertian parasite, I mention, for what it is worth, that this would constitute the only malignant parasite seen by me in a station where malaria was very prevalent.

(*c*) *The advantages of the nomenclature used*

There are many ways of using these Tables for making comparisons with the results obtained by adopting a different classification for the large mononuclear cell.

It is possible to reconstruct Tables 4 and 10 (*a*, *b*) so that each count and the final average will be in conformity with the nomenclature advocated by Lieut.-Col. Sir L. Rogers, I.M.S.

This result will be achieved if the large mononuclear and large lymphocyte percentages are added together; in Table 4, however, as a correction has been made for the average of the whole group, each separate figure for large lymphocytes must also be corrected. This involves much reckoning, all of which is omitted here.

Having arrived at these new results, we can then compare the two sets of tables by applying the test as to how many cases in health and malaria will be incorrectly diagnosed by accepting certain standards for the determination of malarial infection.

The average count for 83 cases of malaria is:

Polymorpho-nuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes	Broken nuclei
58·61	2·99	0·24	14·79	2·64	20·31	0·41

The new 'large mononuclear' percentage will therefore be 14·79 + 2·64, which equals 17·43.

The standard adopted must be below this figure; as it is a purely arbitrary one, different errors will result if we alter it. This being so, let us try the effect of different standards, using 13, 14, 15 and 16.

A series of counts in health and malaria is published by Captain H. Stott, I.M.S., in the *Indian Medical Gazette*, March, 1915, and as these are based on the nomenclature under discussion, the same comparison can be made with these. (It must be noted that my tables and his are not strictly comparable, as he omits mast cells, broken nuclei, and decimal fractions in his counts, and so introduces an error throughout.)

The following approximate percentages of cases will be found to be incorrectly diagnosed, i.e., certain healthy counts will be adjudged malarious and certain malarial bloods will be accounted healthy:

Standard of	13	14	15	16
Tables 4 and 10 (*a*, *b*):—	per cent.	per cent.	per cent.	per cent.
Health (23 cases); diagnosed as malaria	26	26	26	26
Malaria (83 cases); diagnosed as healthy	17	27	35	44
Captain Stott's counts:—				
Health (25 cases); diagnosed as malaria	16	16	12	8
Malaria (163 cases); diagnosed as healthy	22	26	30	39

A simple way of writing these errors is to assume that 50 healthy bloods and 50 malarial bloods are examined. When the 100 counts are then studied with these standards, the percentage errors will be:

	13	14	15	16
	per cent.	per cent.	per cent.	per cent.
My Tables	21·5	26·5	30·5	35·0
Captain Stott's Tables	19·0	21·0	21·0	23·5

Now let us examine the percentage errors obtained when the large mononuclears are disentangled from the large lymphocytes, again using different standards.

Standard of	8	9	10	11	12	13
Tables 4 and 10 (*a*, *b*):—	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Health (23 cases); diagnosed as malaria	17·0	8·5	—	—	—	—
Malaria (83 cases); diagnosed as healthy	1·2	1·2	3·6	10·8	19·0	36·0
Or with 50 healthy bloods and 50 malarial bloods, error will be	9·1	4·8	1·8	5·4	9·6	18·0

Comparing the most favourable standards above, we find the error is very much reduced by adopting this fuller nomenclature. It is also obvious that the best results are obtained by using a standard of 10 per cent. large mononuclears as indicative of malarial infection—in fact, I did so adopt it for precisely these reasons.

Table 4

Differential Blood Counts in Health

Serial No.	Case No.		Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes
84	1H	... ...	69·00	8·00	—	4·00	4·00	15·00
85	2H	... ...	61·00	13·00	—	4·00	9·00	13·00
86	3H	... ...	64·00	22·00	—	3·00	9·00	2·00
87	4H	... ...	65·00	13·00	1·00	1·00	14·00	6·00
88	5H	... ...	55·00	4·00	1·00	8·00	15·00	17·00
89	6H	... ...	75·00	—	—	2·00	10·00	13·00
90	7H	... ...	59·00	7·00	—	7·00	8·00	19·00
91	8H	... ...	55·00	8·00	—	3·00	13·00	21·00
92	9H	... ...	62·00	8·00	—	7·00	6·00	17·00
93	10H	... ...	45·00	6·00	1·00	4·00	20·00	24·00
94	11H	... ...	55·00	17·00	1·00	1·00	2·00	24·00
95	12H	Before meals...	37·50	19·00	0·50	6·00	25·50	11·50
96	—	After meals	46·66	12·33	0·66	5·33	25·33	9·66
97	13H	... ...	61·00	7·00	1·00	9·00	3·00	19·00
98	14H	... ...	62·00	5·00	—	—	8·00	25·00
99	15H	... ...	63·00	7·00	—	5·00	8·00	17·00
100	16H	... ...	53·00	25·00	—	4·00	14·00	4·00
101	17H	Contusion	64·00	—	—	7·00	19·00	10·00
102	18H	,, ...	57·00	20·00	1·00	4·00	14·00	4·00
103	19H	Abrasions	37·00	15·00	1·00	9·00	25·00	13·00
104	20H	,, ...	48·00	11·00	2·00	5·00	26·00	8·00
105	21H	Sprain	53·00	17·00	—	2·00	7·00	21·00
106	22H	,, ...	47·00	17·00	—	4·00	9·00	23·00
107	23H	... ...	65·00	3·00	—	8·00	8·00	16·00
		Arithmetic average	56·63	11·01	0·42	4·68	12·58	14·67
		Corrected average (see Text) ...	56·63	11·01	0·42	4·68	7·79	19·46

Table 5

Differential Blood Count in Lobar Pneumonia

Serial No.	Case No.		Poly-morpho-nuclears	Eosino-philes	Mast cells	Large mono-nuclears	Large lympho-cytes	Small lympho-cytes
108	1LP	... ...	95·00	—	—	3·00	—	2·00
109	2LP	... ...	93·00	—	—	4·00	1·00	2·00
110	3LP	... ...	92·00	—	—	3·00	4·00	1·00
111	4LP	... ...	92·00	—	—	3·00	2·00	3·00
112	5LP	... ...	87·00	1·00	1·00	1·00	3·00	7·00
113	6LP	... ...	80·00	—	—	5·00	5·00	10·00
114	7LP	... ...	81·00	2·00	—	2·00	5·00	10·00
115	8LP	... ...	79·00	2·00	—	3·00	4·00	12·00
116	9LP	... ...	84·00	5·00	—	1·00	3·00	7·00
117	10LP	... ...	95·00	1·00	—	—	1·00	3·00
118	11LP	+ Pleurisy c. Effusion	95·00	—	—	1·00	3·00	1·00
119	12LP	... ...	80·00	1·00	—	—	7·00	12·00
120	13LP	... ...	91·00	—	—	1·00	4·00	4·00
121	14LP	... ...	76·00	10·00	—	2·00	3·00	9·00
122	15LP	... ...	80·00	1·00	—	1·00	5·00	13·00
123	16LP	... ...	94·00	—	—	—	2·00	4·00
124	17LP	... ...	89·00	—	—	3·00	2·00	6·00
125	18LP	... ...	87·00	2·00	—	3·00	1·00	7·00
126	19LP	... ...	93·00	—	—	—	4·00	3·00
127	20LP	... ...	90·00	—	—	1·00	1·00	8·00
128	21LP	... ...	90·00	—	—	—	3·00	7·00
129	22LP	... ...	79·00	7·00	1·00	1·00	5·00	7·00
130	23LP	... ...	91·00	2·00	—	—	1·00	6·00
131	24LP	... ...	84·00	8·00	1·00	2·00	1·00	4·00
132	25LP	... ...	75·00	—	—	4·00	9·00	12·00
133	26LP	... ...	85·00	—	—	4·00	—	11·00
134	27LP	... ...	86·66	—	—	—	3·33	10·00
135	28LP	... ...	82·00	—	—	6·00	2·00	10·00
		Arithmetic average	86·63	1·50	0·11	1·93	3·01	6·82

Table 6

Differential Blood Counts in Broncho-Pneumonia

Serial No.	Case No.		Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes
136	1BP	... ...	77·00	1·00	1·00	2·00	2·00	17·00
137	2BP	... ...	69·00	5·00	—	1·00	5·00	20·00
138	3BP	... ...	83·00	—	—	3·00	6·00	8·00
139	4BP	... ...	83·33	2·00	—	3·33	2·00	9·33
140	5BP	... ...	61·00	1·00	—	1·00	15·00	22·00
141	6BP	... ...	66·00	11·00	—	3·00	—	20·00
142	7BP	... ...	65·00	1·00	—	2·00	9·00	23·00
143	8BP	... ...	76·00	—	—	1·00	7·00	16·00
144	9BP	... ...	63·00	14·00	—	3·00	4·00	16·00
		Arithmetic average	71·48	3·89	0·11	2·15	5·56	16·81

TABLE 7

DIFFERENTIAL BLOOD COUNTS IN BRONCHITIS

Serial No.	Case No.		Poly-morpho-nuclears	Eosino-philes	Mast cells	Large mono-nuclears	Large lympho-cytes	Small lympho-cytes
145	1B	... ...	47·00	20·00	1·00	6·00	19·00	7·00
146	2B	... ...	74·00	3·00	—	3·00	6·00	14·00
147	3B	... ...	65·00	1·00	—	3·00	9·00	22·00
148	4B	... ...	69·00	3·00	—	3·00	4·00	21·00
149	5B	... ...	76·00	2·00	—	5·00	3·00	14·00
150	6B	... ...	52·66	13·33	—	1·33	4·66	28·00
151	7B	... ...	55·00	6·00	—	1·00	10·00	28·00
152	8B	... ...	74·00	2·00	—	2·00	7·00	15·00
153	9B	... ...	77·50	0·50	—	6·00	8·50	7·50
154	10B	... ...	78·00	1·00	—	—	4·00	17·00
155	11B	... ...	85·57	2·57	—	0·57	1·71	9·57
156	12B	... ...	68·00	8·00	1·00	1·00	5·00	17·00
157	13B	... ...	60·00	12·00	—	3·00	3·00	22·00
158	—	5 days later	63·00	12·00	—	3·00	1·00	21·00
159	14B	... ...	69·00	1·00	—	2·00	6·00	22·00
160	15B	... ...	73·10	1·00	—	3·00	3·00	20·00
		Arithmetic average	67·92	5·52	0·13	2·68	5·93	17·82

TABLE 8

DIFFERENTIAL BLOOD COUNTS IN EPIDEMIC RELAPSING 'PNEUMONIA'

Serial No.	Case No.		Poly-morpho-nuclears	Eosino-philes	Mast cells	Large mono-nuclears	Large lympho-cytes	Small lympho-cytes
161	1ER'P'	... ...	40·00	1·00	—	—	8·00	51·00
162	2ER'P'	... ...	42·00	—	—	—	4·00	54·00
163	3ER'P'	... ...	60·00	0·50	—	—	7·00	32·00
164	4ER'P'	... ...	37·00	—	—	—	3·00	60·00
165	5ER'P'	... ...	46·00	1·00	—	—	4·00	49·00
166	6ER'P'	B.	38·00	—	—	—	4·00	58·00
167	7ER'P'	... ...	46·00	—	—	—	—	54·00
		Arithmetic average	44·14	0·36	—	—	4·28	51·22

N.B.—No broken nuclei were seen in the above seven slides.

TABLE 9

DIFFERENTIAL BLOOD COUNTS IN OTHER DISEASES

Serial No.	Case No.		Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes
198	1D	Active Pulm. Tuberculosis ...	49·50	10·75	1·00	5·75	—	33·00
199	2D	,, ,, ,, ...	57·00	5·00	—	3·00	11·00	24·00
200	3D	,, ,, ,, ...	68·00	9·00	—	3·00	8·00	12·00
201	4D	,, ,, c. dry Pleurisy ...	77·00	4·00	—	1·00	7·00	11·00
202	5D	,, ,, ,, ,, ...	63·00	8·00	—	3·00	6·00	20·00
203	6D	,, ,, ,, ,, ...	81·00	—	—	2·00	7·00	10·00
204	7D	,, ,, c. Pl. Effusion ...	57·00	4·00	—	3·00	10·00	26·00
205	8D	Acute Tb. Pneumonia	89·66	0·66	—	1·66	3·33	4·66
206	9D	,, ,, ,, ...	79·00	3·00	—	4·00	4·00	10·00
207	10D	Anaemia and Debility	41·00	11·00	—	2·00	10·00	36·00
208	11D	,, ,, ,, ...	71·00	1·00	—	2·00	2·00	24·00
209	12D	,, Post-malarial	70·50	8·50	—	8·50	3·50	9·00
210	13D	*Ascaris lumbricoides*	59·33	19·33	—	—	0·66	20·66
211	14D	,, ,, ...	59·00	15·00	—	2·00	4·00	20·00
212	15D	Dysentery	70·00	3·00	—	1·00	2·00	24·00
213	16D	Dyspepsia	39·00	7·00	—	6·00	22·00	26·00
214	17D	Enteric Fever, 1st day	80·00	3·00	1·00	1·00	5·00	10·00
215	—	,, ,, 2nd day	79·00	1·00	—	—	9·00	11·00
216	18D	Gonorrhoeal Rheumatism	74·00	—	—	4·00	13·00	9·00
217	19D	Hepatitis. M. Bp.	79·00	—	—	2·00	10·00	9·00
218	20D	Myalgia Rheumatica	60·00	12·00	1·00	4·00	4·00	19·00
219	20D	,, ,, later ...	58·00	13·00	—	1·00	1·00	27·00
220	21D	Orchitis	61·00	10·00	—	4·00	21·00	4·00
221	22D	Relapsing Fever (*Sp. carteri* ?) ...	57·00	1·00	—	2·50	12·00	27·50
222	23D	,, ,, ,, ...	69·33	4·66	—	2·66	7·33	16·00
223	24D	Scabies	52·00	10·00	—	3·00	23·00	12·00
224	25D	Suppurative Mastitis	76·80	12·00	0·80	3·20	0·40	6·80
225	26D	Tertiary Ulcer	38·66	9·33	0·66	4·00	24·00	26·66
226	27D	'Chill with Fever'	86·00	7·50	—	1·00	—	5·50
227	28D	,, ,, ,, ...	69·00	5·00	1·00	1·00	5·00	19·00
228	29D	,, ,, ,, ...	51·00	16·00	—	—	2·00	31·00
229	30D	,, ,, ,, ...	66·50	6·50	0·50	3·50	3·00	22·00
230	31D	,, ,, ,, ...	67·33	4·66	—	1·33	6·00	20·66
231	32D	,, ,, ,, ...	52·00	1·00	—	2·00	10·00	35·00
232	33D	,, ,, ,, ...	58·00	13·33	—	6·66	1·33	20·66
233	34D	,, ,, ,, ...	70·00	2·00	—	4·00	9·00	15·00
234	35D	,, ,, ,, ...	78·00	8·00	1·00	1·00	3·00	12·00
235	36D	,, ,, ,, ...	65·00	8·00	—	4·00	6·00	17·00
236	37D	,, ,, ,, ...	68·50	10·00	—	0·50	1·50	19·50
237	38D	,, ,, ,, ...	62·00	—	—	3·00	13·00	22·00

M. = Megalocytes.

Bp. = *Basophilia punctata.*

TABLE 10

DIFFERENTIAL BLOOD COUNTS IN MALARIA

(*a*) Amongst Gurkhas

Serial No.	Case No.	Remarks	Cells counted	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes	Broken nuclei
1	1	BT. FF.	—	66·00	7·00	0·66	14·66	—	11·66	—
2	2	BT. FF. SF.	—	66·00	—	1·00	10·00	—	23·00	—
3	3	BT. FF.	—	55·00	12·00	—	14·00	4·00	15·00	—
4	4	BT. FF. P.	—	57·00	1·00	—	26·00	10·00	6·00	—
5	5	BT. FF. B.	—	65·00	—	—	18·00	12·00	5·00	—
6	6	BT. FF. SF.	—	78·00	2·00	—	15·00	4·00	1·00	—
7	30	BT. FF.	—	49·50	6·50	0·50	15·00	9·00	19·50	—
8	34	BT. FF. SF.	—	58·50	10·00	0·50	16·50	1·00	13·50	—
9	38	BT. FF. SF.	—	65·00	8·00	1·50	6·00	—	19·50	—
10	40	BT. SF.	—	74·00	6·00	—	10·00	2·00	8·00	—
11	41	BT. FF. SF.	—	75·00	3·00	—	12·00	3·00	7·00	—
12	42	BT. FF. Bp.	—	65·00	1·00	2·00	17·00	3·00	12·00	—
13	43	BT. FF. P.	—	36·33	26·66	0·33	19·00	3·00	14·66	—
14	44	BT. FF. B. Bp. P. ...	—	52·00	0·66	—	13·33	1·33	32·66	—
15	45	BT. FF. SF.	—	63·00	—	—	15·00	2·00	20·00	—
16	46	BT. FF. B. Bp.	—	55·00	2·00	1·00	14·00	3·00	25·00	—
17	47	BT. FF. SF.	—	52·00	2·00	—	18·00	14·00	14·00	—
18	48	BT. FF. SF.	—	71·00	4·00	—	18·00	2·00	5·00	—
19	49	BT. FF. SF.	—	58·00	8·00	—	11·00	2·00	21·00	—
20	51	BT. FF.	—	67·00	3·00	—	18·00	7·00	5·00	—
21	7	MT. FF. SF. B.	—	28·50	2·00	1·00	26·50	—	42·00	—
22	8	MT. FF.	—	37·00	19·00	1·00	8·00	2·00	33·00	—
23	9	MT. FF. SF. Bp. ...	—	49·00	2·00	—	22·00	5·00	22·00	—
24	10	MT. FF.	—	53·00	2·00	—	19·00	6·00	20·00	—
25	29	MT. FF. SF.	—	46·00	12·00	—	24·00	8·00	10·00	—
26	31	MT. FF. SF. B. Bp. N.	—	48·66	1·66	—	10·00	7·33	32·33	—
27	35	MT. FF.	—	54·00	3·00	1·00	18·00	2·00	22·00	—
28	36	MT. FF. B. P.	—	48·66	15·33	0·66	12·66	2·66	20·00	—
29	37	MT. FF.	—	71·00	—	—	17·00	—	12·00	—
30	50	MT. FF. SF.	—	80·00	1·00	—	10·00	—	9·00	—
31	52	BT. FF. B.	200	74·50	—	0·50	12·00	3·00	8·50	1·50
32	53	BT. FF.	100	65·00	4·00	—	12·00	4·00	13·00	2·00
33	54	BT. FF. SF. P.	150	42·00	2·00	—	12·66	3·33	39·33	0·66
34	55	BT. FF. P.	200	64·00	5·00	—	11·50	1·50	17·50	0·50
35	56	BT. FF. SF.	100	60·00	1·00	—	8·00	—	31·00	—
36	57	BT. FF. SF. P.	200	59·00	3·00	—	18·50	0·50	18·50	0·50
37	58	BT. FF. SF.	200	54·00	7·00	1·00	15·00	—	23·00	—
38	59	BT. FF. SF. P.	200	34·50	7·50	—	17·50	4·00	36·50	—
39	60	MT. SF. B.	100	42·00	4·00	—	11·00	1·00	42·00	—
Arithmetic average, Benign Tertian, Serial Nos. 1-20; 31-38			—	60·05	4·73	0·32	14·56	3·52	16·64	0·18
Arithmetic average, Malignant Tertian, Serial Nos. 21-30 and 60			—	50·71	5·64	0·33	16·20	3·09	24·03	—

ABBREVIATIONS

BT. = Benign Tertian
MT. = Malignant Tertian
FF. = Fever forms
SF. = Sexual forms
B. = *Basophilia diffusa* or Polychromasia
Bp. = *Basophilia punctata*
P. = Pigment in Large Mononuclears
N. = Nucleated Red Cells seen

TABLE 10.—(*Continued*)

(*b*) Amongst Sikhs, Jats, Dogras and Punjabis

Serial No.	Case No.	Remarks	Cells counted	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes	Broken nuclei
40	61	BT. FF.	400	72·00	—	—	14·00	—	14·00	—
41	62	BT. FF.	400	67·00	1·00	—	12·00	3·00	15·50	1·50
42	63	BT. FF. Bp.	400	66·00	—	1·00	13·00	7·00	12·00	1·00
43	64	BT. FF.	400	74·00	1·00	—	13·00	—	11·00	1·00
44	65	BT. FF.	400	67·00	1·00	—	13·00	3·00	16·00	—
45	66	BT. FF. SF. B.	400	63·00	—	—	12·00	—	25·00	—
46	67	BT. FF. SF. B.	400	42·00	9·00	—	19·00	3·00	25·00	2·00
47	68	BT. FF.	600	37·33	1·33	0·66	14·66	4·00	41·00	1·00
48	69	BT. FF. SF.	400	79·00	—	—	10·50	1·00	9·50	—
49	70	BT. FF. SF.	400	60·00	1·00	—	15·00	3·00	20·00	1·00
50	71	BT. FF.	400	75·00	1·00	—	15·00	1·00	6·00	2·00
51	72	BT. FF. SF.	400	45·00	—	—	15·00	5·00	34·00	1·00
52	73	BT. FF. SF. B.	400	65·00	1·00	—	14·00	—	20·00	—
53	74	BT. FF. P.	400	72·00	—	—	12·00	1·00	15·00	—
54	75	BT. FF. P.	400	64·00	—	—	14·00	2·00	18·00	2·00
55	76	BT. FF. P.	400	41·00	1·00	—	19·00	6·00	33·00	—
56	77	BT. FF.	400	54·00	—	—	12·00	4·00	30·00	—
57	78	BT. FF. SF. P.	400	48·00	1·00	—	18·00	2·00	30·00	1·00
58	79	BT. FF. SF. P.	400	62·00	—	—	16·00	—	22·00	—
59	80	BT. FF. SF.	400	78·00	—	—	11·00	4·00	7·00	—
60	81	BT. FF. SF.	400	49·00	—	—	25·00	4·00	20·50	1·50
61	82	BT. FF.	400	52·00	1·00	—	15·00	—	32·00	—
62	83	BT. FF. SF. B.	400	61·00	—	—	20·00	2·00	17·00	—
63	84	BT. FF. P.	400	39·00	4·00	1·00	14·00	—	42·00	—
64	85	BT. FF. SF.	400	66·00	2·00	1·00	12·00	—	19·00	—
65	86	BT. FF.	400	75·00	—	—	14·00	—	11·00	—
66	87	BT. FF.	400	71·00	—	—	10·00	—	19·00	—
67	88	BT. FF. B.	400	71·00	3·00	1·00	13·00	—	10·00	2·00
68	89	BT. FF.	400	45·00	4·00	—	20·00	1·00	28·00	2·00
69	90	BT. FF.	400	65·00	1·00	—	11·00	—	23·00	—
70	91	BT. FF. B.	400	72·00	—	1·00	11·00	—	14·00	2·00
71	92	BT. FF.	400	57·00	1·00	—	16·00	7·00	15·00	4·00
72	93	*BT. FF.	400	51·00	—	—	17·00	5·00	27·00	—
73	94	*BT. FF.	400	74·00	—	—	13·00	—	13·00	—
74	95	*BT. FF.	400	60·00	—	—	12·00	5·00	23·00	—
75	96	*BT. FF.	400	66·00	6·00	2·00	14·00	—	11·00	1·00
76	97	*BT. FF.	400	54·00	1·00	—	16·00	2·00	26·00	1·00
77	98	*BT. FF. B.	400	39·00	1·00	—	19·00	4·00	36·00	1·00
78	99	*BT. FF.	400	72·00	2·00	—	12·00	—	14·00	—
79	100	*BT. FF.	400	66·00	—	—	12·00	1·00	20·00	1·00
80	101	*BT. FF.	400	46·00	—	—	15·00	3·00	35·00	1·00
81	102	*BT. FF.	400	48·00	5·00	—	14·00	7·00	26·00	—
82	103	Quartan. FF. SF.	400	38·00	—	—	12·00	—	50·00	—
83	104	*Plasmodium tenue.* FF. ...	400	72·00	1·00	—	11·00	2·00	14·00	—
Arithmetic average, Benign Tertian, Serial Nos. 40-81			—	60·25	1·17	0·18	14·46	2·14	21·08	0·71

ABBREVIATIONS

BT. = Benign Tertian
FF. = Fever forms
SF. = Sexual forms
B. = *Basophilia diffusa* or Polychromasia
Bp. = *Basophilia punctata*
P. = Pigment in Large Mononuclears

* In these cases malaria was diagnosed upon blood count alone. The parasite was found later—and only after prolonged search.

TABLE 11

DIFFERENTIAL BLOOD COUNTS IN CONVALESCENCE FROM MALARIA

Week	Serial No.	Case No.	Remarks, etc.	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes
1st week	268	7	4 days later. P.	38·00	1·00	—	23·00	7·00	31·00
	269	8	4 ,, ...	37·00	18·00	—	13·00	4·00	28·00
	270	12	4 ,, MT. FF. B.	51·00	—	—	21·00	13·00	15·00
	271	6	7 ,, ...	46·00	13·00	—	14·00	4·00	23·00
	272	10	7 ,, ...	60·66	8·66	—	12·00	8·00	10·66
	273	29	7 ,, ...	49·00	16·00	—	11·00	4·00	20·00
	274	31	7 ,, B.	36·50	10·50	—	10·00	1·50	41·50
	275	40	7 ,, N.	65·33	10·00	—	8·00	0·66	16·00
2nd week	276	35	10 days	38·00	11·00	2·00	19·00	6·00	24·00
	277	36	10 ,, ...	70·00	7·00	—	11·00	3·00	9·00
	278	2	14 ,, ...	49·50	15·00	1·00	15·00	12·00	7·50
	279	3	14 ,, ...	40·00	18·00	—	12·00	9·00	21·00
	280	5	14 ,, ...	76·00	5·50	—	8·00	0·50	10·00
	281	7	14 ,, ...	69·00	2·00	—	15·00	7·00	8·00
	282	8	14 ,, ...	45·50	26·00	1·00	6·50	1·50	19·50
3rd week	283	13	* 18 days	66·00	4·00	—	16·00	7·00	7·00
	284	12	19 ,, ...	56·00	3·00	1·50	15·50	3·50	20·50
	—	11	19 ,, *vide* Table 2	68·00	4·00	—	15·00	6·00	7·00
	285	14	* 19 ,, ...	55·00	5·00	—	15·00	15·00	10·00
	286	15	* 20 ,, ...	46·66	8·66	0·66	20·00	12·00	12·00
	287	16	* 21 ,, ...	46·00	7·00	—	19·00	14·00	14·00
	288	31	21 ,, Relapse. BT. FF. SF. B. Sd.	29·00	2·66	—	35·33	5·33	27·66
4th week	289	17	22 days. MT. SF.	69·00	1·00	—	19·00	2·00	9·00
	290	18	22 ,, Relapse. BT. FF. B. ...	52·00	2·00	2·00	18·00	10·00	16·00
	291	19	* 23 ,, ...	64·00	13·00	—	3·00	12·00	8·00
	292	17	25 ,, Before meals	41·00	3·00	—	22·00	22·00	12·00
	293	—	After meals	65·00	1·00	—	15·00	15·00	4·00
	294	7	27 ,, N.	46·00	7·00	1·00	11·00	4·00	31·00
	295	11	27 ,, MT. SF.	51·00	10·00	—	16·00	13·00	10·00
5th week	296	5	32 days. Relapse. BT. FF. Sd. ...	68·00	1·00	1·00	14·00	6·00	10·00
	297	19	34 ,, ...	71·00	4·00	1·00	3·00	8·00	13·00
	298	31	35 ,, 14 days from Relapse ...	51·50	18·50	—	13·00	1·00	16·00
	299	36	35 ,, ...	61·50	6·00	—	10·00	—	22·00
	300	41	35 ,, Relapse. BT. FF. ...	73·00	—	—	14·00	1·00	12·00
6th week	301	12	36 days	39·33	14·66	0·66	12·00	7·33	26·00
	302	18	36 ,, 14 days from Relapse ...	57·00	6·00	—	10·00	9·00	18·00
	303	8	37 ,, ...	40·00	33·00	—	6·00	3·00	18·00
	304	1	42 ,, ...	36·66	26·66	1·33	14·00	6·00	15·33
	305	2	42 ,, Relapse. BT. FF. ...	66·66	2·00	—	14·66	7·33	9·39
	306	7	42 ,, ...	56·00	5·00	—	12·00	5·00	22·00
	307	11	42 ,, ...	42·00	5·00	—	15·00	19·00	19·00
	308	14	42 ,, ...	65·00	12·00	—	11·00	2·00	10·00
	309	15	42 ,, ...	61·00	2·50	—	14·00	5·00	17·50
	310	16	42 ,, ...	32·00	11·00	—	12·00	10·00	35·00
7th week	—	20	43 days. *Vide* Table 2	44·00	21·00	1·00	13·00	1·00	20·00
	311	1	49 ,, ...	43·00	24·00	5·00	11·00	7·00	10·00
	312	19	49 ,, ...	55·00	10·00	—	15·00	4·00	16·00
8th week	313	12	50 days	43·00	22·00	—	12·00	6·00	17·00
	314	17	53 ,, MT. SF.	74·00	1·00	1·00	14·00	3·00	7·00
	315	30	54 ,, BT. SF. Marked Leucocytosis	77·50	7·50	—	2·50	1·50	11·00
	316	31	55 ,, 34 days from Relapse. BT. FF. SF. Sd. No fever	56·00	4·00	—	17·00	6·00	17·00
	317	18	56 ,, Relapse. BT. FF. ...	46·00	5·00	—	21·00	6·00	22·00

TABLE 11.—(*Continued*)

Week	Serial No.	Case No.	Remarks, etc.	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes
9th week	318	20	59 days. Relapse. MT. FF. SF. Bp.	67·00	6·00	—	14·00	7·00	6·00
	319	7	63 ,, ...	62·00	—	—	11·00	4·00	23·00
	320	18	63 ,, 7 days from Relapse	32·00	5·00	—	33·00	12·00	18·00
10th week	321	11	65 days. Relapse. MT. FF. SF. B. Infection 1/500 r.b.cs.	43·00	2·00	—	22·00	9·00	24·00
	322	13	65 ,, ...	64·00	10·00	2·00	10·00	3·00	11·00
	323	2	66 ,, Relapse. BT. FF. Bp. Sd. 24 days from last Relapse	76·00	—	1·00	13·00	4·00	6·00
	324	14	66 ,, ...	56·00	8·00	—	12·00	5·00	19·00
	325	16	67 ,, Bp.	56·00	5·00	—	10·00	6·00	23·00
11th week	326	15	75 days	52·00	11·00	0·50	6·50	0·50	29·50
12th week	327	6	80 days	51·00	9·00	—	10·00	12·00	18·00
13th week	328	5	88 days	38·00	25·00	—	8·00	7·00	22·00
	329	8	89 ,, ...	42·00	20·00	—	5·00	3·00	30·00
15th week	330	13	103 days	70·00	11·00	—	3·00	—	16·00
16th week	331	12	106 days	58·00	7·00	—	6·00	6·00	22·00
	332	20	110 ,, 51 days from Relapse ...	64·00	6·00	—	9·33	7·33	13·33
	333	7	110 ,, ...	77·00	3·00	—	4·00	4·00	12·00
	334	31	112 ,, 91 days from Relapse ...	59·50	16·00	—	2·00	2·00	20·50
17th week	335	2	115 days. 49 days from Relapse ...	54·00	8·00	—	13·00	12·00	13·00
18th week	336	11	123 days. SF.	57·00	3·00	—	6·00	7·00	27·00
	337	16	125 ,, ...	47·00	16·00	—	10·00	5·00	22·00
	338	2	126 ,, 60 days from Relapse ...	50·00	2·00	—	9·00	12·00	27·00
19th week, etc.	339	1	131 days. Megalocytes	58·00	14·00	—	4·00	5·00	19·00
	340	17	133 ,, Bp.	70·00	6·00	—	5·00	3·00	16·00
	341A	2	172 ,, Pneumonia. *Vide* Table 5 ...	82·00	—	—	6·00	2·00	10·00
	341	30	182 ,, ...	50·00	4·66	—	3·33	6·00	36·00
	342	29	232 ,, ...	69·00	11·00	1·00	1·00	1·00	17·00
	343	10	233 ,, ...	46·00	25·00	1·00	7·00	3·00	18·00
	344	6	250 ,, ...	61·00	11·00	—	3·00	7·00	18·00
	345	9	253 ,, ...	47·00	6·00	—	—	1·00	46·00
		12	255 ,, Bronchitis. *Vide* Table 7 ...	73·00	1·00	—	3·00	3·00	20·00
		14	280 ,, ,, ,, ,, ...	78·00	1·00	—	—	4·00	17·00
	346	16	296 ,, ...	61·00	9·00	—	12·00	7·00	11·00
	347	19	298 ,, ...	55·00	7·00	—	6·00	1·00	30·00
	348	15	303 ,, ...	71·00	7·00	—	1·00	1·00	20·00

NEW ABBREVIATIONS.—Sd. = Schüffner's dotting especially marked.

* Benign Tertian parasites were found during primary attack, but no count was then made.

Table 12

The Large Mononuclear Averages of the Previous Table are set out below in Progressive Weeks. Where a Relapse Occurs, this is Indicated with the Initial 'R,' and the Count of that Date Starts Again at 'First Day of Fever.'

Case No.	Day, 1st	Wk. 1	Wk. 2	Wk. 3	Wk. 4	Wk. 5	Wk. 6	Wk. 7	Wk. 8	Wk. 9	Wk. 10	Wk. 11	Wk. 12	Wk. 13	Wk. 14	Wk. 15	Wk. 16	Wk. 17	Wk. 18	Wk. 19, etc.
1	14⅔	—	—	—	—	—	14	11	—	—	—	—	—	—	—	—	—	—	—	4
2	10	—	15	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—
	14⅔	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	13	—	—	—	—	—	—	13	9	—	—	—	—	—	—	—	—	—	—	—
3	14	—	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	18	—	8	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—
	14	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—
6	15	14	—	—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	3
7	26½	23	15	—	11	—	12	—	—	11	—	—	—	—	—	—	4	—	—	—
8	8	13	6½	—	—	—	6	—	—	—	—	—	—	5	—	—	—	—	—	—
9	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
10	19	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
11	20½	—	—	15	16	—	15	—	—	—	R	—	—	—	—	—	—	—	—	—
	22	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—
12	—	21	—	15½	—	—	12	—	12	—	—	—	—	—	—	—	6	—	—	3
13	—	—	—	16	—	—	—	—	—	—	10	—	—	—	—	3	—	—	—	—
14	—	—	—	15	—	—	11	—	—	—	12	—	—	—	—	—	—	—	—	0
15	—	—	—	20	—	—	14	—	—	—	—	6½	—	—	—	—	—	—	—	1
16	—	—	—	19	—	—	12	—	—	—	10	—	—	—	—	—	—	—	10	12
17	—	—	—	—	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
					22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
					15	—	—	—	14	—	—	—	—	—	—	—	—	—	—	5
18	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	18	—	10	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	21	33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	3	3	—	15	—	—	—	—	—	—	—	—	—	—	—	6
20	20½	—	—	—	—	—	—	13	—	R	—	—	—	—	—	—	—	—	—	—
	14	—	—	—	—	—	—	—	9⅓	—	—	—	—	—	—	—	—	—	—	—
29	24	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
30	15	—	—	—	—	—	—	—	*2½	—	—	—	—	—	—	—	—	—	—	3⅓
31	10	10	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	35⅓	—	—	13	—	17	—	—	—	—	—	—	—	2	—	—	—	—	—	—
35	18	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36	12⅔	—	11	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—
40	10	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
41	12	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The Arithmetic Averages for first day of fever in the above table, which includes a few counts from Table 10, and for successive weeks are as follows:—

1st day of fever	...	...	Observations 27	...	Average 16·88
1st week of Convalescence	...	...	,, 10	...	,, 16·40
2nd ,, ,,	...	...	,, 7	...	,, 11·07
3rd ,, ,,	...	...	,, 7	...	,, 16·21
4th ,, ,,	...	...	,, 6	...	,, 14·33
5th ,, ,,	...	...	,, 3	...	,, 10·00
6th ,, ,,	...	...	,, 8	...	,, 12·00
7th ,, ,,	...	...	,, 4	...	,, 13·00
8th ,, ,,	...	...	,, 5	...	,, 10·47*
9th ,, ,,	...	...	,, 2	...	,, 8·50
10th ,, ,,	...	...	,, 3	...	,, 10·06
11th ,, ,,	...	...	,, 1	...	,, 6·50
12th ,, ,,	...	...	,, 1	...	,, 10·00
13th ,, ,,	...	...	,, 2	...	,, 3·50
14th ,, ,,	...	...	,, 0	...	,, —
15th ,, ,,	...	...	,, 1	...	,, 3·00
16th ,, ,,	...	...	,, 2	...	,, 5·00
17th week and onwards	...	...	,, 13	...	,, 4·18

* Excluding 2½.

TABLE 13

DIFFERENTIAL BLOOD COUNTS FROM WHICH MALARIA WAS DIAGNOSED

Serial No.	Case No.	Remarks, etc.	Cells counted	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes	Broken nuclei
238	11	... ...	—	46·50	6·50	—	20·50	—	26·50	—
239	11	19 days later	—	68·00	4·00	—	15·00	6·00	7·00	—
		27 ,, ,, MT. SF. ...	—	51·00	10·00	—	16·00	13·00	10·00	—
		42 ,, ,, ...	—	42·00	5·00	—	15·00	19·00	19·00	—
		65 ,, ,, MT. FF. SF. B. Infection 1/500	—	43·00	2·00	—	22·00	9·00	24·00	—
		123 ,, ,, MT. SF. ...	—	57·00	3·00	—	6·00	7·00	27·00	—
240	20	... ...	—	56·00	2·75	0·25	20·50	—	20·50	—
241		43 days later	—	44·00	21·00	1·00	13·00	1·00	20·00	—
		58 ,, ,, MT. FF. SF. Bp.	—	67·00	6·00	—	14·00	7·00	6·00	—
		109 ,, ,, ...	—	64·00	6·00	—	9·33	7·33	13·33	—
242	21	4 days after fever. B. P.	—	53·00	11·00	—	17·00	16·00	3·00	—
243	22	4 ,, ,, ,, B. P.	—	61·00	—	—	13·00	8·00	18·00	—
244		15 ,, ,, ,, ...	—	69·00	6·00	—	13·00	—	12·00	—
245	23	17 ,, ,, ,, ...	—	64·00	5·00	1·00	15·00	5·00	10·00	—
246	24	23 ,, ,, ,, ...	—	40·00	39·33	0·66	8·00	6·00	5·99	—
247	25	32 ,, ,, ,, ...	—	38·00	17·00	—	23·00	12·00	10·00	—
248		50 ,, ,, ,, ...	—	48·00	11·00	—	16·00	8·00	17·00	—
249	26	36 ,, ,, ,, ...	—	42·00	4·00	1·00	16·00	22·00	15·00	—
250		66 ,, ,, ,, ...	—	46·66	16·66	—	11·33	6·00	19·33	—
251	27	41 ,, ,, ,, ...	—	47·00	25·00	—	14·00	11·00	3·00	—
252		63 ,, ,, ,, ...	—	49·00	13·00	—	15·00	8·00	15·00	—
253	28	48 ,, ,, ,, ...	—	43·00	6·00	1·00	16·00	11·00	23·00	—
254	32	Bp.	—	60·66	1·33	—	18·66	2·66	16·66	—
255		3 days after fever	—	56·00	3·00	—	18·00	12·00	11·00	—
256	33	4 ,, ,, ,, B. Bp.	—	29·00	1·00	—	18·00	10·00	42·00	—
257	34	P.	—	41·00	—	—	19·00	13·00	27·00	—
		200 days later. BT. FF. SF.	—	58·50	10·00	0·50	16·50	1·00	13·50	—
258	35	... ...	—	33·00	6·00	—	15·00	15·00	31·00	—
		32 days later. MT. FF. ...	—	54·00	3·00	1·00	18·00	2·00	22·00	—
		10 days after fever	—	38·00	11·00	2·00	19·00	6·00	24·00	—
259	39	... ...	—	64·00	2·00	—	19·00	5·00	10·00	—
260	105	N.A.D. ... ... 1 day after; BT. FF.	200	44·00	14·00	—	13·50	1·00	27·00	0·50
261	106	... ...	400	52·00	1·00	—	16·50	8·00	22·50	—
262	107	... ...	400	76·00	1·00	—	13·00	—	10·00	—
263	108	... ...	400	61·00	—	1·00	16·00	2·00	20·00	—
264	109	P.	400	47·00	—	—	15·00	1·00	37·00	—
265	110	P.	400	70·00	—	—	11·00	—	19·00	—
266	111	*	400	72·00	0·50	—	10·50	1·50	15·50	—
267	112	... ...	400	67·00	—	—	11·00	3·50	17·00	1·50
Arithmetic average of all cases diagnosed on counts			30	52·93	7·27	0·19	15·34	6·49	17·70	0·07
Average of cases relapsing later			12	52·71	5·94	0·10	15·46	5·08	20·67	0·04
,, ,, left			18	53·07	8·16	0·26	15·28	7·43	15·72	0·08

Serial Numbers 238-260 were counts from Gurkhas, remainder from Sikhs, Jats, etc.

ABBREVIATIONS

MT. = Malignant Tertian
BT. = Benign Tertian
P. = Pigment in Large Mononuclears
FF. = Fever forms
SF. = Sexual forms
B. = *Basophilia diffusa*
Bp. = *Basophilia punctata*
N.A.D. = No appreciable disease

* I was informed afterwards that this case had malaria 23 days earlier.

TABLE 14

DIAGNOSIS BY BLOOD COUNT DURING AND AFTER AN EPIDEMIC

Serial No.	Case No.	Date of admission	Diagnosis returned	My diagnosis from symptoms spleen, chart, etc.	Independant blood findings	Large mono-nuclears
31	M1	Mar. 5	Malaria	Malaria	BT. FF. B. ...	12·00
32	M2	,, 3	,, ...	,, ...	BT. FF.	12·00
349	M3	,, 3	,, ...	No appreciable disease	... ...	2·00
350	M4	,, 3	,, ...	Adenitis of neck	Leucocytosis ...	—
351	M5	,, 3	,, ...	,, ,, ...	... ...	1·00
33	M6	,, 3	,, ...	Malaria	BT. SF. P. ...	12·66
34	M7	,, 2	,, ...	,, ...	BT. SF. P. ...	11·50
39	M8	,, 2	,, ...	,, ...	MT. SF. B. ...	11·00
352	M9	,, 2	,, ...	,, ...	B. P.	11·50
353	M10	,, 1	,, ...	No evidence of malaria. C. ...	... ...	2·00
354	M11	Feb. 27	,, ...	Malaria, typical chart	... ...	15·50
355	M12	,, 27	,, ...	No evidence of malaria. C. ...	... ...	3·50
356	M13	,, 25	,, ...	Malaria	... ...	14·00
357	M14	,, 25	Gumboil	Gumboil	... ...	0·50
358	M15	,, 25	Dyspepsia	Dyspepsia	... ...	2·50
359	M16	—	... ...	Sick attendant	... ...	0·50
360	M17	—	... ...	,, ,, ...	... ...	1·50
361	M18	Feb. 23	Malaria	Chart atypical	... ...	2·00
362	M19	,, 23	,, ...	,, missing	... ...	10·80
363	M20	,, 23	,, ...	,, atypical	... ...	4·00
364	M21	,, 20	,, ...	,, typical	... ...	10·50
365	M22	,, 17	,, ...	,, ,, ...	... ...	11·00
366	M23	,, 15	,, ...	,, ,, ...	... ...	10·00
367	M24	,, 13	,, ...	Only admitted 2 days	... ...	0·66
368	M25	,, 8	,, ...	Chart typical	... ...	10·00
369	M26	,, 6	,, ...	,, atypical	Leucocytosis ...	2·75
370	M27	,, 4	,, ...	,, typical	... ...	11·00
371	M28	,, 3	,, ...	,, lost	... ...	12·00
372	M29	,, 1	,, ...	,, atypical	... ...	3·00
373	M30	Jan. 29	,, ...	,, ,, ...	... ...	1·00
374A	M31	,, 27	,, ...	,, typical. Relapsing ...	BT. FF. SF. ...	8·00
374	M32	,, 24	,, ...	,, ,, ...	... ...	16·00
375	M33	,, 21	,, ...	,, ,, ...	... ...	10·50
376	M34	,, 21	,, ...	,, atypical	... ...	5·00
377	M35	,, 21	,, ...	Only 3 days' admission	... ...	4·00
378	M36	,, 21	,, ...	Chart lost	... ...	3·00
379	M37	,, 21	,, ...	,, atypical	... ...	4·50
380	M38	,, 20	,, ...	,, typical	Bp.	13·00
381	M39	,, 19	,, ...	,, ,, ...	... ...	13·00
382	M40	,, 19	,, ...	,, ,, ...	... ...	16·50
383	M41	,, 18	,, ...	,, ,, ...	B. Bp.	18·50
384	M42	Jan. 4	Diarrhoea	... ...	... ...	4·00
385	M43	,, 2	,, ...	Chart typical. Relapsing ...	BT. FF. SF. P.	18·50
386	M44	Dec. 26	,, ...	,, ,, ...	... ...	12·00
387	M45	,, 26	,, ...	,, ,, ...	... ...	10·50
388	M46	,, 25	,, ...	,, ,, 9 days' fever ...	... ...	18·00
389	M47	,, 25	,, ...	,, ,, ...	... ...	17·00
390	M48	,, 23	,, ...	Only admitted 1 day	... ...	3·00
391	M49	,, 22	,, ...	Chart lost	... ...	5·00
392	M50	,, 20	,, ...	,, typical	... ...	9·00
393	M51	,, 19	,, ...	,, ,, ...	... ...	10·00
394	M52	,, 17	,, ...	,, ,, ...	... ...	9·50
395	M53	,, 16	,, ...	,, ,, ...	... ...	22·00
37	M54	,, 14	,, ...	,, ,, Relapsing ...	BT. FF. SF. ...	15·00
396	M55	,, 14	,, ...	,, ,, ...	... ...	9·33
397	M56	,, 10	,, ...	,, atypical	... ...	3·00
			NO PREVIOUS ADMISSIONS			
38	59	—	... ...	... ...	BT. FF. P. ...	17·50
260	105	—	... ...	Admitted next day with BT. ...	... ...	13·50

C. = Convalescent.

Table 14.—(Amplified.)

Serial No.	Case No.	Remarks, etc.	Cells counted	Polymorphonuclears	Eosinophiles	Mast cells	Large mononuclears	Large lymphocytes	Small lymphocytes	Broken nuclei
31	M1	BT. FF. B.	200	74·50	—	0·50	12·00	3·00	8·50	1·50
32	M22	BT. FF.	100	65·00	4·00	—	12·00	4·00	13·00	2·00
349	M3	... ...	100	57·00	15·00	1·00	2·00	5·00	20·00	—
350	M4	Leucocytosis	200	74·50	12·50	—	—	—	13·00	—
351	M5	... ...	200	72·00	4·50	—	1·00	2·00	20·50	—
33	M6	BT. SF. P.	150	42·00	2·00	—	12·66	3·33	39·33	0·66
34	M7	BT. SF. P.	200	64·00	5·00	—	11·50	1·50	16·50	0·50
39	M8	MT. SF. B.	100	42·00	4·00	—	11·00	1·00	42·00	—
352	M9	B. P.	200	46·00	4·50	—	11·50	1·50	36·50	—
353	M10	... ...	200	58·00	7·00	—	2·00	1·50	30·00	1·50
354	M11	... ...	200	64·00	2·50	—	15·50	3·50	12·00	2·50
355	M12	... ...	200	74·00	0·50	0·50	3·50	1·50	19·50	0·50
356	M13	... ...	200	54·00	5·00	0·50	14·00	4·50	21·50	0·50
357	M14	... ...	200	45·00	13·50	—	0·50	2·50	38·50	—
358	M15	... ...	200	65·00	8·50	—	2·50	2·50	23·00	—
359	M16	Sick attendant	200	62·50	11·00	—	0·50	1·00	25·00	—
360	M17	,, ,, ...	200	73·50	3·50	—	1·50	1·00	20·50	—
361	M18	... ...	200	59·00	9·00	—	2·00	2·00	27·00	1·00
362	M19	... ...	250	48·80	14·00	1·20	10·80	1·20	24·00	—
363	M20	... ...	100	56·00	13·00	—	4·00	2·00	25·00	—
364	M21	... ...	200	47·00	13·50	0·50	10·50	1·50	27·00	—
365	M22	... ...	200	54·50	11·00	—	11·00	0·50	23·00	—
366	M23	... ...	200	66·50	1·00	—	10·00	—	22·50	—
367	M24	... ...	150	42·66	22·00	1·33	0·66	0·66	32·66	—
368	M25	... ...	200	53·00	11·00	—	10·00	2·00	24·00	—
369	M26	Leucocytosis	400	59·00	0·50	0·25	2·75	0·50	36·00	1·00
370	M27	... ...	200	42·50	30·00	1·00	11·00	1·50	13·50	0·50
371	M28	... ...	200	71·00	1·00	—	12·00	1·00	15·00	—
372	M29	... ...	100	72·00	6·00	—	3·00	2·00	17·00	—
373	M30	... ...	100	57·00	15·00	—	1·00	1·00	26·00	—
35	M31	BT. FF. SF.	100	60·00	1·00	—	8·00	—	31·00	—
374	M32	... ...	200	50·00	6·00	—	16·00	6·00	21·00	1·00
375	M33	... ...	200	62·50	3·50	0·50	10·50	0·50	22·50	—
376	M34	... ...	200	57·00	9·00	—	5·00	0·50	28·50	—
377	M35	... ...	200	59·50	6·50	—	4·00	1·50	28·50	—
378	M36	... ...	200	63·00	14·00	—	3·00	—	20·00	—
379	M37	... ...	200	52·50	12·00	—	4·50	5·00	26·00	—
380	M38	Bp.	200	40·00	25·00	1·00	13·00	—	21·00	—
381	M39	... ...	100	60·00	4·00	—	13·00	2·00	19·00	2·00
382	M40	... ...	200	35·00	11·00	—	16·50	4·00	32·50	1·00
383	M41	B. Bp.	200	61·50	6·00	—	18·50	1·50	12·50	—
384	M42	... ...	200	57·00	11·50	—	4·00	1·50	26·00	—
385A	M43	BT. FF. SF. P.	200	59·00	3·00	—	18·50	0·50	18·50	0·50
386	M44	... ...	200	62·00	13·00	1·00	12·00	1·00	10·00	1·00
387	M45	... ...	200	47·00	16·00	0·50	10·50	0·50	24·50	1·00
388	M46	... ...	200	53·00	4·00	0·50	18·00	3·50	19·50	1·00
389	M47	... ...	200	52·00	13·00	—	17·00	—	17·00	1·00
390	M48	Leucopoenia	100	46·00	19·00	1·00	3·00	1·00	30·00	—
391	M49	... ...	200	47·00	9·00	—	5·00	1·00	38·00	—
392	M50	... ...	200	47·00	18·00	1·00	9·00	—	25·00	—
393	M51	... ...	100	49·00	20·00	1·00	10·00	1·00	19·00	—
394	M52	... ...	200	50·00	13·00	—	9·50	2·50	24·50	0·50
395	M53	... ...	100	35·00	7·00	—	22·00	9·00	26·00	1·00
37	M54	BT. FF. SF.	200	54·00	7·00	1·00	15·00	—	23·00	—
396	M55	... ...	300	32·00	6·33	—.	9·33	0·33	52·00	—
397	M56	... ...	200	47·00	20·00	—	3·00	1·00	29·00	—

The illness in the case of Nos. M42-M56, below the line, occurred more than 8 weeks from the date the slide was taken (i.e., March 5).

REFERENCES

Stott, H. (1915). Studies in Malaria, Part III. *Ind. Med. Gaz.*, L., pp. 85-91. (See p. 88.)